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AUTOMATION OF HYDROPONICS

Abstract: The word «Hydroponics» is defined as any means to grow plants via a medium that does not include the use of soil but involves inorganic nutrients or nutrient solution. The hydroponic controller project accomplishes automation by utilizing various microcontrollers, sensors, and IoT (Internet of Things – the networking capability that allows information to be sent to and received from objects and devices using the Internet) technology for remote monitoring, and control. In the most basic description of its operation, the system takes inputs from the sensors and provides a controlling action to keep different parameters in the desired range.

It is a system that is cost-effective and, most importantly, is completely automated and requires virtually no human interaction after placing the germinated plant into the system. Automatic control facilitates plant breeding. But another aspect is to create a system that can be used by a typical consumer; meaning that it is relatively small and simple to use.

Growing plants in the growing box requires constant attention, and each plant species also has its own needs, which often do not match for different types, as a result, we need a device that can be easily reconfigured to another plant species. Control of lighting, temperature and humidity, irrigation – all this can be controlled in automatic mode with the help of automation for a growing box.

Automated hydroponics systems currently on the market are either very expensive or do not control all the parameters necessary for a healthy plant growth.

Keywords: hydroponics, hydroponic controller, nutrient solution, microcontrollers, sensors, automation, humidity.

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АВТОМАТИЗАЦИЯ ГИДРОПОНИКИ

Аннотация: Слово «Гидропоника» определяется как любое средство для выращивания растений через среду, которая не включает в себя использование почвы, но включает в себя неорганические питательные вещества или питательный раствор. Проект гидропонный контроллер выполняет автоматизацию, используя различные датчики и технологию интернет вещей, которая позволяет отправлять и получать информацию с объектов и устройств, использующих Интернет, для удаленного мониторинга и управления. В самом основном описании своей деятельности система принимает входные сигналы от датчиков и предусматривает контроль различных параметров.

Это система, которая является экономически выгодной и, самое главное, полностью автоматизированной, практически не требует человеческого взаимодействия после помещения растения в устройство. Автоматический контроль облегчает селекцию растений. Но другой аспект заключается в создании системы, которая может быть использована типичным потребителем; это означает, что она относительно мала и проста в использовании.

Выращивание растений требует постоянного внимания, и у каждого вида растений есть свои потребности, которые часто не совпадают у разных видов, в результате нам нужно устройство, которое можно легко перенастроить на другой вид растений. Контроль освещения, температуры и влажности – все это можно контролировать в автоматическом режиме с помощью автоматики для гидропоники.

Автоматизированные системы гидропоники в настоящее время на рынке либо очень дороги, либо не контролируют все параметры, необходимые для здорового роста растений.

Ключевые слова: гидропоника, гидропонный контроллер, питательный раствор, микроконтроллер, датчик, автоматизация, влажность.

Basic requirements of hydroponics

In horticulture, hydroponics is a form of agriculture where plants are not grown in soil, but rather in trays or grow beds by a constant flow of nutrient solution.

In any hydroponics system, the following basic requirements must be maintained at optimum levels:

a) buffer action of water or the inert medium used;

b) the nutrient solution or the fertilizer mixture used must contain all micro and macro elements necessary for plant growth and development;

c) buffer action of the nutrient solution must be in a suitable range so that plant root system or the inert medium is not affected;

d) the temperature and aeration of the inert medium or the nutrient solution are suitable for plant root system.

Hydroponic system

One of the key advantages of hydroponics is that a gardener totally controls all aspects of the growing environment. Therefore, the success of the crops will depend on the growing conditions provided. Give them the proper lighting, water, nutrients, oxygen, feeding schedule, etc., and plants can grow really fast, very large (to their full genetic potential), and yields can be much higher than traditional soil gardening.

One of the most important decisions a grower should make is a choice of a hydroponic system. In Figure 1 six main types of the hydroponic system are shown. While hydroponics is the method of growing plants using only water and nutrients instead of soil, a hydroponic system is the hydroponics technique you use to grow your plants. Each technique works a little differently – most systems use growing medium, some use pumps and timers, and some systems are better suited for particular gardening applications and crop varieties than others.

Shreya Tembe [1] wrote about the features of each of the considered hydroponic systems.

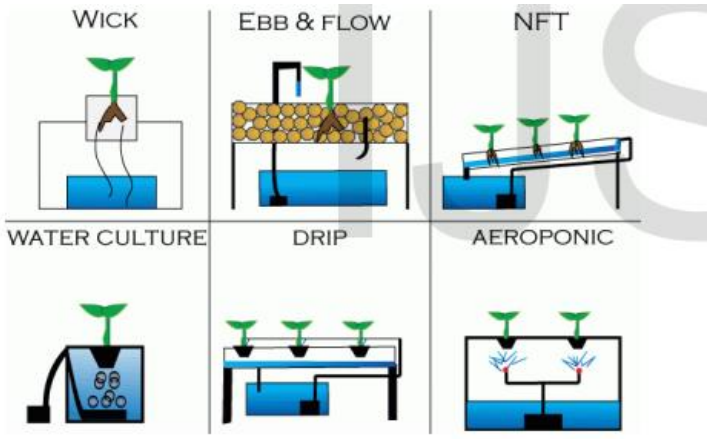

Figure 1 – Types of the hydroponic systems

Nutrients for hydroponics

As we have already understood, a nutrient solution is needed for hydroponics. Now we have to understand what substances should be included in its composition.

As we are growing plants without soil, we miss out on a good deal of nutrients that soil contains. So, exactly what makes up a bottle of nutrients?

The NPK ratio tells exactly how much of each macro nutrient the bottle contains. If a bottle says 9-9-9, this means that the solution contains 9% Nitrogen, 9% Phosphorus, and 9% Potassium. Therefore, the liquid will be up to 27% nutrients. In the other 73% is water, micro nutrients and other chelating agents make up the rest of the solution.

More details about the concentration of nutrients in the solution are described in article [2]. The authors of the article say: «Each nutrient has a suitable concentration and relative ratios for the normal growth of a plant, and these are the target values of a nutrient control system».

Development of the device

Over the years, traditional farming with the use of soil medium consumes a lot of space and water; not on that, but it is also prone to pest attacks, resulting in higher use of pesticides. Our approach is to make an Automated Hydroponic System reducing labour cost as well as improving the quality of plants cost effectively.

The main node of the circuit is a microcontroller: to perform all the functions we need, the microcontroller must show the information about the status of the farm on the display, monitor the water level in the tank, manage watering, as well as, provide watering plants on schedule.

The best choice for solving the task is the ATMEG328 microcontroller. It has such an interface as: I2C this interface allows to

connect using only two lines (SCK and SDA (clocking and data)), manage multiple devices. The main thing is that the line capacity (between SCK and SDA) does not exceed 300 pF since at large capacity, a differentiating effect begins.

The next important element for the construction of this scheme is the control unit, it was decided to use an encoder as a control element; as it will allow navigating through the menu, however, a simple incremental encoder tracks only turns. In order to select the mode of operation, it is also necessary to provide a button for selection. Since there are encoders with a built-in button, it was decided to stop on this option.

In order the roots of the plants are constantly moistened they must be regularly watered. A water pump is ideal for this task, as it can raise water to a high level. However, the current output of the microcontroller is quite small, so to control the pump, there was a need to put a driver. The simplest solution is a transistor switch. It was decided to dwell on it, because there is no need to change the direction of water flow, and it is necessary to develop a device as cheap as possible.

Since the input supply voltage of the circuit is 12V, and the voltage of the microcontroller is 5V, there is a need to use a power source. Since the consumption current is insignificant on the 5V line, it is quite expensive to assemble a pulse converter for this device, so it was decided to use a linear stabilizer, since it is simple to manufacture, cheap and takes up little space.

Since the liquid in the tank runs out, it is necessary to put a system for tracking. For this purpose two devices were supplied: the first is an ultrasonic distance sensor, it hangs on the bottom of the container with the plant and being reflected from the water in the tank, determines its level; the second is the level on the infrared LED, this design is put on the bottom of the tank, and when the water level drops, the channel broken by water is restored, and the device signals the need to refuel the tank. After beta testing, it will be decided which device is better suited to monitor fluid levels.

To implement the function of watering in time, it was decided to put a real time clock. Since the microcontroller clocking comes from a crystal oscillator with a frequency of 16 MHz, and an error of 20 ppm, if we try to implement the microcontroller time counting algorithm, we will get a rather significant accumulation of error in time. Therefore, it was decided to use DS3231, since this module has an I2C connection, which reduces the number of lines used, and can also control the operation of the piezo

emitter, thus realizing the function of sound confirmation of pressing, as well as an alarm, when the device leaves the operating mode.

Finally, the last block we need to foresee is an output block. This block is necessary because the device provides interactive control. The best solution would be to use a display with an I2C bus connection, which would save the number of leads, as well as simplify the routing of the printed circuit board; it would also be good to use a display with low consumption. And in accordance with all the required parameters a display was found, it turned out to be OLED with a resolution of 128x64. Since this is an OLED, the consumption of this display will not be significant. 128x64 pixels extension is quite enough to display the device settings, and the chip used in the display will allow you to connect it via the I2C bus.

This block diagram in figure 2 was designed from article [3].

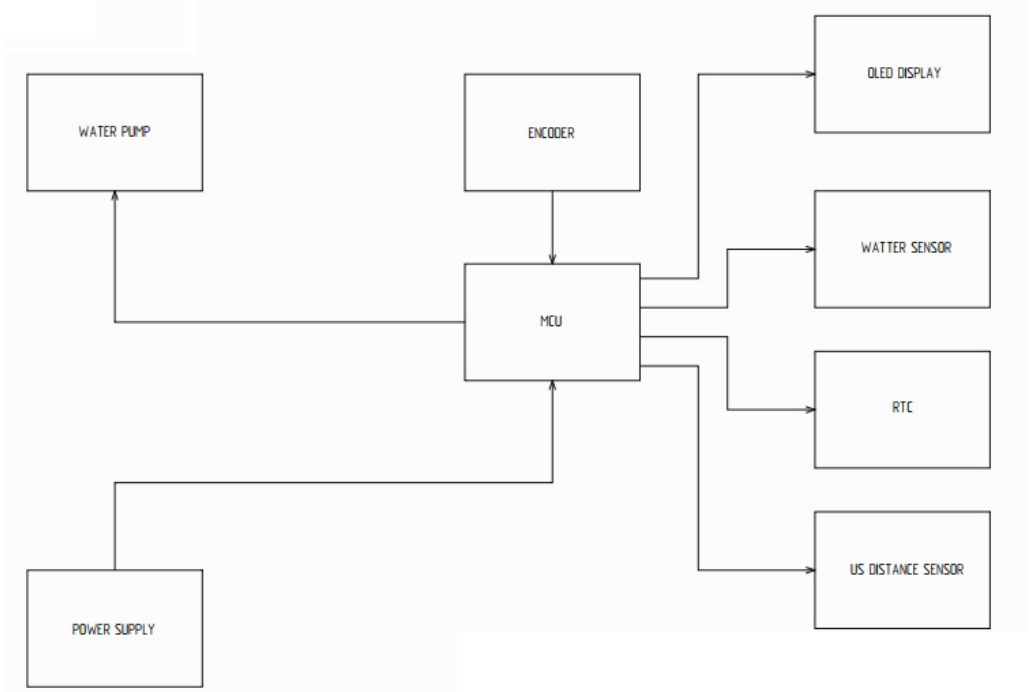

Figure 2 – The block diagram of the device controller hydroponic farm

This paper presents the development of the electrical circuit of the prototype for its further creation and improvement.

The designed system is very helpful for reducing the system cost and manpower. The device is useful in hydroponics method of cultivation and suitable for small space, low cost, low consumer power and able to recycle the nutrient solution which is already used by plant.

This system needs to be improved, should be more thought and cost effective. That is why it must become fully automatic, controlling other parameters such as pH, temperature, light intensity, ambient humidity, oxygen level in water. This task will be solved in the future.

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